and water, we shall see that there is no reason whatever why the air at the equator should be hotter in January than in July.

It is well known that, notwithstanding the nearness of the sun in January, the influence of the present distribution of land and water is sufficient to make the mean temperature of the whole earth, or, what is the same, the mean temperature of the air over the surface of the earth higher in July than in January. The reason of this is obvious. Nearly all the land is in the northern hemisphere, while the southern hemisphere is for the most part water. The surface of the northern or land-hemisphere, for reasons to which I need not here refer, becomes heated in summer and cooled in winter to a far greater extent than the surface of the southern or water hemisphere. Consequently when we add the July or midsummer temperature of the northern to the July temperature of the southern hemisphere, we must get a higher number than when we add the January or midwinter temperature of the former to the January temperature of the latter. For example, the mean July temperature of the northern hemisphere, according to Dove ("Distribution of Heat on the Surface of the Globe") is 70°·9, and that of the southern hemisphere 53°·6; add the two together and we have 124°·5, which gives a mean for both hemispheres of 62°·3. The mean January temperature of the northern hemisphere is 48°·9, which, added to 59°·5, the mean January temperature of the southern hemisphere, gives only 108°·4, or a mean of 54°·2. Consequently the air over the surface of the globe is hotter in July by 8° than in January, notwithstanding the effects of eccentricity. It is obvious that, were it not for the counteracting effects of eccentricity, the difference would be much greater. Ten thousand years ago, when eccentricity and the distribution of land and water combined to produce the same effect, the difference must have been far greater than 8°.

But it will be asked, How can this affect the air over the equator, which is not situated more on the one hemisphere than on the other? It is true that those causes have but little *direct* effect on the air at the equator, but *indirectly* they have a very powerful influence. The air is continually flowing in to the equatorial regions from both hemispheres. In fact, the air which we find there is derived entirely from the temperate regions. In July we have the northern trades coming from a hemisphere with a mean temperature as high as 70°·9, and the southern trades coming from a hemisphere with a mean temperature not under 53°, while in January the former trades flow from a hemisphere as low as 50°, and the latter from a hemisphere no higher than 60°. Consequently the air which the equatorial regions received from the trades must have a higher temperature in July than in January. The northern is the dominant hemisphere; it pours in hot air in July and cold air in January, and this effect is not counterbalanced by the air from the opposite hemisphere. The mean temperature of the air passing into the equatorial regions ought therefore to be much higher in July than in January, and this it no doubt would be were it not, let it be observed, for the counteracting effects of eccentricity. The tendency of the present distribution of land and water, when our northern winter occurs in perihelion, is to counteract the effects of eccentricity. But ten thousand years ago, when our winters were in aphelion, that cause would co-operate to intensify the effects of eccentricity. In fact, it would actually more than double the effects then produced by eccentricity. Now if the influence of the present distribution of land and water is so great as not merely to counteract but to reverse the effects of eccentricity to the extent of making the mean temperature of the earth 8° warmer in July than in January, it is not surprising that it should be sufficient to make the equatorial regions at least as warm in the former as in the latter period.

The fact that the equator at present is not hotter when the earth is in perihelion, instead of being an objection to the theory that the glacial period was due to an increase of eccentricity, as Mr. Fisher supposes, is in reality another strong argument in its favour, for it shows that a much less amount of eccentricity would suffice to induce a commencement of glacial conditions in the northern hemisphere than would otherwise be required, were it not for the circumstance to which Mr. Fisher refers. This objection, like many others which have been urged against the theory, arises from looking too exclusively at the *direct* effects of eccentricity.

There is another cause which must also tend to lower the January and raise the July temperature of the equator, viz., the northern trades pass further south in January than in July, and consequently cool the equatorial regions more during the former than the latter season. This general tendency of the trades to lower the temperature of the equatorial regions more in January than in July is of course subject to modifications from the monsoons, the rainy seasons, and other local causes; nevertheless, so long as the present distribution of land and water endures, so long will eccentricity have a counteracting effect upon the temperature of the air at the equator, which but for that would be hotter in July than in January.

Mr. Fisher somewhat misapprehends what he designates my "fundamental proposition." What I stated was "the temperature of a place *other things being equal* is proportional to the heat received from the sun." Those who have read what I have written on this point will remember that what I mean is, that if the temperature of any place depended alone on the direct heat of the sun that temperature would be proportional to the amount received. But then there is no such spot on the face of the globe—there is no place where heat or cold distributed by ocean or aërial currents does not affect the temperature—and I have in "Climate and Time," pp. 41–44, proved that, with the exception of the Arctic regions, there is no part where the temperature is so much affected by those currents as the equator. Were it not for the cooling effect produced by them the equator would be uninhabitable. No knowledge whatever as to the intensity of the sun's heat can be obtained from observations on the temperature of the air at the equator. The comparatively cold air flowing in from the temperate regions has not time to be fully heated by the sun's rays before it rises as an ascending current and returns to the temperate regions from whence it came. More than this these trades prevent us from being able to determine with accuracy the intensity of the sun's heat from the temperature of the ground; for the surface of the ground in equatorial regions is kept at a much lower temperature by the air blowing over it than is due to the intensity of the sun's heat. It thus becomes a very intricate problem to determine how much the surface of the ground is kept below the maximum temperature by the heat absorbed by the moving air.

I may add that although my estimates of the lowering effect resulting from the decrease of the sun's heat arising from increase of distance were computed according to Newton's law, yet I distinctly stated that this law holds only approximately true, but that nevertheless, for reasons given at p. 34 of "Climate and Time," it would be found near enough for my purpose.

JAMES CROLL

A Possible Consequence of our Present Weather

I HAVE observed on several occasions that abnormally cold weather in November has been followed by an unusually mild mid-winter and January. These may possibly have been mere accidental coincidences, or they may be connected by a link of causation thus. Our climate, and more especially our winter climate, is largely influenced by the Gulf Stream, and whatever augments this raises our winter temperature, and *vice versâ*.

How, then, is the Gulf Stream likely to be affected by an unusual prevalence of Arctic winds and unusual cold in these latitudes? Such winds, must, to some extent, drive the waters of the Atlantic towards the source of the Gulf Stream, and tend to heap them there, and if there is any truth in the theory which attributes ocean currents to differences of oceanic temperatures, the present unusually cooled waters of the temperate zone will co-operate with the winds and augment this accumulation by their underflow. I do not mean that these combined actions are reversing the Gulf Stream at the present time, but simply that they are exerting a counter action or retarding influence which must result in augmenting the normal magnitude of the reservoir, or tropical accumulation, the outflow of which constitutes the Gulf Stream, and that thus the volume and velocity of the tropical waters which usually flow towards our coast will be augmented when the pressure of the present Arctic winds shall cease, and that our climate will be influenced accordingly. If I am right we may, in spite of present symptoms, or rather on account of them, have an unusually warm Christmas season and January.

This idea is not thrown out as a mere weather prophecy, but as a suggestive hypothesis and an incentive to what appears to me to be a very important and a much neglected branch of meteorological research, viz., systematic observation and record of the variations of the Gulf Stream. The countries whose coast is washed by this beneficent river of ocean are deeply interested in its movements. The Norwegians have already done something towards recording its variations, but so far as I can learn we, who are almost as deeply concerned as they are, have done little or nothing

It may be that our agricultural troubles of the past three years are in some measure due to its disturbance; if so, it is of national importance that we should study its variations in order to learn whether they are reducible to law, and thus capaple of anticipations sufficiently reliable to induce prudential preparation for their national consequences. W. MATTIEU WILLIAMS

Stonebridge Park, Willesden

[With the extreme desirableness of an immediate and systematic observation, by European nationalities, of the temperature of the Gulf Stream, and of variations in the rate and direction of movement northwards from the tropics of the warm water and of the cold water southwards we very cordially concur. As another illustration of the practical utility of a better knowledge than we now possess of this subject, we may refer to the higher temperature and consequently larger evaporation than usual of the Atlantic in lower latitudes, along with a lower temperature, and consequently lower evaporation than usual farther north, in the beginning of the winter of 1878-79, as being in all likelihood one of the chief causes which brought us the miserable weather of the last twelve months. It is far from being beyond the reach of science to show how the larger evaporation from the more southerly regions of the Atlantic continued to spread itself over Europe further to south than usual, from which resulted the more southerly course pursued by our European storms, with the accompanying plague of east wind and rains over the British Isles, and the commercial distress thus deepened and prolonged. The importance of the inquiry is all the greater when it is considered that the past three years have impressively taught us how, not in India only, as shown by Blanford, but also in our British climate, certain types of weather, such as cold, warm, wet, or dry, when once fairly set in, tend to repeat themselves, and stamp their character on whole seasons or even a succession of seasons. It is by such lines of research that something more than a mere guess of the weather of coming seasons is to be obtained.—ED.]

The Climate of England

WILL you permit me, as a student for twenty years of the phenomena and laws of weather, to express my surprise that in meteorological tables or records, and weather notices in general, so little attention is bestowed upon the direction of the wind? It is true that in the daily forecasts issued from the Meteorological Office, this has been made for some time past a prominent, and, to my mind, the most valuable feature. Still the point has by no means been adequately dwelt upon by writers upon meteorology, the result being the loose and utterly unscientific talk we are accustomed to hear upon the very first principles of the problem of climate.

What is more common than to hear people remark that the climate of England has changed within the last few years? Their main ground for saying so is our having had for four or five seasons winters of exceptional mildness, followed last year by one of as remarkable severity and duration, and to all appearance likely to have following it one of not very different character.

The popular idea of climate has always seemingly been that of something affixed to the soil, a feature as fixed and characteristic as the rivers or mountain chains. Now, strictly speaking, there are for us but two real sources or loci of climate, the pole and the equatorial belts; the cold heavy currents of air from the Arctic regions flowing south, to take the place of the light warm air so rarefied by the sun's heat as to form a comparative vacuum. The aerial set of flux and reflux thus tending to be set-up along meridian lines is deflected eastwards by the rotation of the earth on its axis, with the result that in our part of the earth at least the wind is found to blow from some point of west to east for much about 200 days out of the 365. So limited is our sea-girt insular area, that within a few hours, depending on the velocity of the wind, the whole breadth of Great Britain is traversed, so that instead of breathing a climate engendered by local conditions, and to be called our own, we live in an atmosphere reaching us from abroad, and modified by the conditions through which it passes to us (into which I forbear at present to enter in detail). Observation combines with theory to establish the primary fact that what may be called the ruling line or axis of prevailing wind in our island is that from south-west to north-east approximately. Along this line may be said to take place, in the main, the perennial contest of opposing air-currents, on which depends the character of our seasons, the light warm balmy breath of the equatorial current, or so-called Gulf Stream, having to battle with the dry, heavy, chilling atmospheric masses bearing down direct from the Polar regions, or circling over the steppes of Russia, or the uplands of Scandinavia. Drawing a line at right angles to this, or from north-west to south-east, we shall find that so long as the wind keeps well within the south westerly aspect of this diagonal, frost either sharp or long is with us impossible, and as an immediate response to the vane veering or backing from one side to the other, a rise or fall of the thermometer is to be observed, which may vie with that due to the sun's place in the zodiac. The mercury may be seen to stand as high in January as in June. If we ask why the four or five winters preceding the last severe one were so exceptionally mild, the proximate answer is that during the months when the sun's power continued low, we enjoyed a succession of south-westerly winds which tempered "winter's flaw." Last year, on the contrary, the wind kept early and persistently to the northerly and easterly quarters; and were proper tables available, I believe that an abnormal prevalence of those Polar currents would be shown to have marked the later seasons of this most exceptional year.

The problem is thus shifted a step.

What we have to inquire into is the cause or causes to which is due so exceptional and persistent a flow of wind from one alternative quarter to the other.

To aim at anything like a forecast of winter or summer weather before knowing what the prevalent set of the aërial currents is to be, is to invert the essential conditions of the problem, and to put the cart before the horse. It is for meteorologists, I would urge, to concentrate their attention upon the causes or laws, which determine or disturb the periodical motions of the earth's envelope, especially as it oscillates to and fro across the limited and exceptionally situated group of the British Islands. Simple as such a suggestion may appear to men of science, the notices they have as yet given us will by no means, I believe, show it to be superfluous. It is the conviction that the primary and elementary conditions of the problem are far from having been grasped by the general public that has led me thus far to trespass upon your space.

Gray's Inn, December 2 ALEXANDER TAYLOR

A Correction

A FEW weeks ago I had some correspondence with the late Mr. J. Allan Broun on the subject of my communication to NATURE, vol. xx. p. 54, in the course of which he drew my attention to an error in my value for the barometric oscillation corresponding to 1° F. $\left(q = \frac{\Delta p}{\Delta t}\right)$ at Sibsagar. He said:—

"You had a note on the difference of results for Lucknow and Sibsagar both nearly at the same height; the values of q you made 0·017 and 0·028, the latter for Sibsagar should have been 0·018 or $\frac{\Delta p}{\Delta t} = \frac{0{\cdot}477}{26{\cdot}6}$."

I acknowledge the error, and take this opportunity of mentioning it as I fear Mr. Broun's article on the subject, which he told me was shortly to appear in NATURE, and in which he would most probably have drawn attention to my error, has been cut short by his sudden and lamented decease. His last letter to me containing the above correction was dated November 15, just a week before he died.

I may add that while the above error (which was due to my taking Δt to be 16·6 instead of 26·6) disqualifies Sibsagar from demonstrating that the value of q depends on the distance from the coast independently of the altitude, the rule is nevertheless generally evident, and can be shown equally well by taking Goalpara instead of Sibsagar with Lucknow.

At Goalpara $h = 386$ feet,

$$q = \frac{\Delta p}{\Delta t} = \frac{0{\cdot}448}{18°{\cdot}7} = 0{\cdot}023.$$

E. DOUGLAS ARCHIBALD

Tunbridge Wells, November 29

Monkeys in the West Indies

IN his very interesting paper on "Tails," which appeared in NATURE, vol. xx. p. 510, Prof. Mivart says, "Monkeys are scattered over almost all the warmest parts of the earth save the West Indies, Madagascar, New Guinea, and Australia." As regards the West Indies the statement is not quite correct, and I am sure Prof. Mivart will be glad to receive the following